motion of the axis is about 47° in 25,800 years. This period, in spite of its enormous length, can not explain the climatic variation of the past geologic periods, except a mutual change of climate between the northern and southern hemispheres. As regards the displacement of the poles on the earth's surface, the amount of the motion is, to-day, negligible.

Mr. Cordeiro tries to develop a theory of the displacement of the earth's axis in the earliest time on the basis of the moon's tidal effect, and thus to explain the cause of the glacial periods of the earth. A discussion of his theory is beyond the limits of the present article.

"Pendulation" theory.[1]—According to the "pendulation" theory, the earth, besides its rotation on its axis, is also swinging on an axis extending through the earth from Sumatra to Ecuador with an amplitude of from 30° to 40°. Each swing corresponds to a geological period. In the paleozoic period the motion brought Europe northward and reached in the Permean age the first glacial period. During the Mesozoic period, the swing changed southward and Europe reached the Cretaceous period with subtropical climate. In the Tertiary, the swing was again toward the north until the Diluvian, when the second glacial period occurred. Since then the swing changed toward the south, etc. It is not the aim of the present article to go into the details of the theory, but it is necessary to add that it does not explain fully the climatic changes during the different periods, and in the different parts of the earth's surface.

Other theories.—Besides the above-described theories, a number of different explanations also have been proposed. Arrhenius and others believe that the percentage of carbon dioxide of the earth's atmosphere has been different in the different periods. Others also tried to attribute the climatic changes to cosmic causes such as the change of the eccentricity of the earth's orbit, and others to volcanic action, to the dislocation of strata and to the distribution of the seas. In fact, no one of all these theories can offer a full explanation of the climatic changes.[2]

Conclusion.—It is believed to be beyond any doubt that the cause of the climatic changes in the different periods is not a single one and that these changes are a compound effect of a great many factors. The fact that no one of the above-mentioned theories can explain fully the climatic changes does not mean that all these theories are entirely wrong. It is very probable that several of the above reasons have contributed to a certain extent. It seems that, in trying to find the solution of this enigma, the best thing to do is to combine the possibilities instead of attributing the phenomenon to certain entirely isolated reasons.

[1] Cf. Simroth, Dr. Heinrich: Die pendulationstheorie, Leipzig, 1907; and Eckardt, Wilhelm R.: Paleoklimatologie, Leipzig, 1910.

[2] See W. J. Humphreys, Physics of the air, 1920, pp. 556–629; also Prof. Arldt, of Radelberg, in a publication under the title "Die Ursachen der Klimaschwankungen der Vorzeit, besonders der Eiszeiten," *Zeitschrift fur Gletscherkunde*, Band XI, p. i-27, 1918, has grouped and discussed the different theories on the subject. An abstract of his article appeared in *Science*, Jan. 7, 1921, pp. 22–23.

THE FREEZING OF PEACH BUDS.[1]

By EARL S. JOHNSTON, PH. D.

[Author's abstract.]

[University of Maryland, College Park, Md., April, 1921.]

It is very desirable that some physical measurement of the hardiness of fruit buds be worked out before the relationship between various environmental conditions and the loss of fruit due to spring freezes can be determined definitely. Some experiments carried on at the University of Maryland Agricultural Experiment Station during the early part of the present year (January to March, 1921) indicate an increase in the tenderness of peach buds with the approach of spring. By means of a portable galvanometer and a needle-type thermocouple inserted in the bud which was then exposed to low temperature (about 7° F.) the freezing point of the sap within the bud could very easily be determined. Other data obtained indicate that wet buds freeze at higher temperature than dry buds. A period of cold weather immediately following a rain is thus apparently more dangerous to a peach orchard than cold weather alone. The accompanying table illustrates the change in resistance offered by peach buds of the Elberta variety to low temperatures.

Average determinations made from the lateral fruit buds of Elberta peach given in degrees Fahrenheit.

Date of experiment....	Jan. 21.	Jan. 26.	Feb. 12.	Feb. 18.	Feb. 25.	Mar. 5.	Mar. 11.	Mar. 14.
Temperature at which ice crystals formed..........	17.8	19.2	17.8	18.1	18.5	19.0	19.4	22.3
Freezing point of sap......	21.0	22.1	20.3	21.6	21.6	22.8	24.4	24.6

In the discussion of Dr. Johnston's paper, Dr. A. D. Hopkins mentioned an unusual feature in connection with the damage to foliage in the freeze of March 29, 1921. On some Ginkgo, mulberry, and even some apple trees there were whole branches on which the leaves and flowers suffered no damage whatever, while all the green parts on the other branches of the same trees were killed. Dr. Hopkins marked these with copper tags, in order to see if in future springs when freezes occurred the same branches showed corresponding hardiness. If they do, as seems likely, it would appear advisable to grow cuttings from these hardy branches and in that way develop a frost-resistant tree. This would be of great value in fruit raising.

[1] Presented before American Meteorological Society, Washington, D. C., Apr. 20, 1921.